Application of Carrier and Fixed Stand for TPS Vacuum Chamber

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Abstract:

The TPS (Taiwan Photon Source) project is now under civil construction. The vacuum chamber system contains 24 unit cells, and the length of each cell is about 14m. The maximum assembly deviation and elastic deformation of TPS vacuum chamber are 0.3mm and 2mm, respectively. In this paper, the specific Carrier and Fixed Stand are considered to be designed. The Carrier includes an I beam, worm gear screw jacks, H frames and JIGS's. The JIGS locked with a vacuum chamber. H frames are connected between an I beam and JIGS's. An I beam is the primary part of loading when moving and lifting a Carrier. Fixed Stand is a hollow column part. A cell of vacuum chamber uses 17 Fixed Stands. We adjust four nuts in conjunction with four M16 bolts bonded on the ground to reach the accuracy of position of a Fixed Stand and to overcome the insufficient ground flatness. The measured data obtained from a laser tracker show that the maximum elastic deformation of Carrier is 2mm, the position deviations of Fixed Stand are ±0.2mm with 1mm tolerance in X and Y axes, respectively, while ±0.1mm in Z(height) axis. The design specification of a Carrier and Fixed Stand is available when a vacuum chamber is moving, lifting, depositing and baking.

1-Introduction

TPS (Taiwan Photon Source) is a new 3-GeV ring under construction at the NSRRC site in Taiwan. The vacuum chamber system contains 24 unit cells, and the length of each cell is about 14m. It is necessary that the appropriate equipment is available for moving and lifting vacuum chambers after completing them. In addition, to perform baking test and avoid deformation, the other equipment is properly considered to deposit and protect vacuum chamber before assembling storage ring in TPS. The maximum assembly deviation and elastic deformation of TPS vacuum chamber are 0.3mm and 2mm, respectively. After checking and designing, a Carrier and Fixed Stand will be designed for vacuum chamber. In this paper we will show the design details, deformation analysis, installation process and assembly deviation of a Carrier and Fixed Stand.

2-Design of Carrier

The Carrier, whose length is 14m, includes an I beam, worm gear screw jacks, H frame and JIGS's, as shown in Fig. 1. In the beginning, we assemble an I beam and worm gear screw jacks, and then align the position of H frame. In addition, we lock JIGS's to a vacuum chamber. Finally, we lock the H frame to JIGS's, and the assignment of moving and lifting can then be performed by using a Carrier. An I beam is the primary part of loading when moving and lifting a Carrier. The maximum elastic deformation and weight of I beam are designed to be under 2mm and 5ton, respectively. The result of stress analysis of I beam through SolidWorks commercial software is shown in Fig. 2.

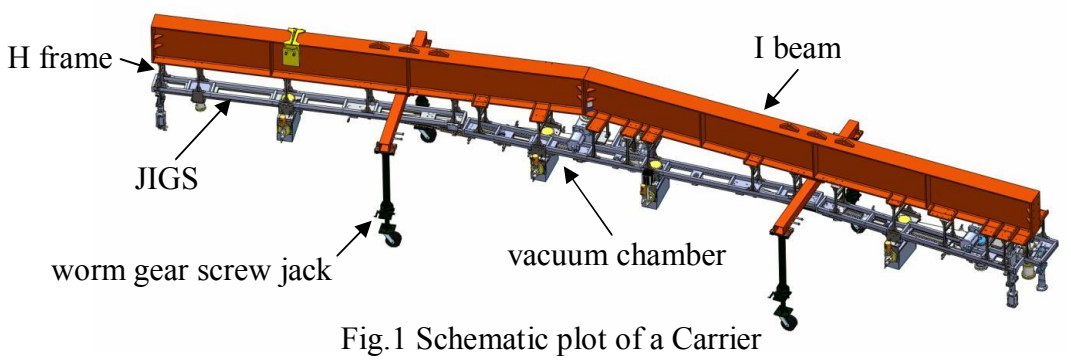


Fig.1 Schematic plot of a Carrier

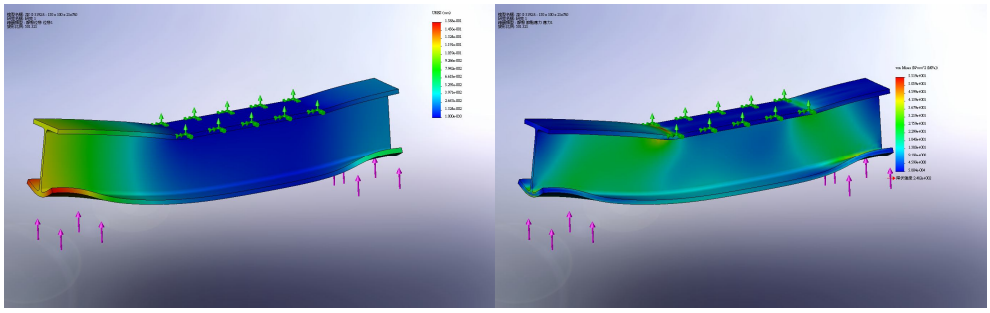


Fig.2 Results of stress analysis of an I beam

3-Design and Installation of Fixed Stand

3.1 Design of Fixed Stand

After moving the Carrier vacuum chamber to depot and the locking JIGS's to Fixed Stands, we will unload the vacuum chamber on the Fixed Stands, as shown in Fig. 3. The positions of 17 Fixed Stands of consideration are designed to the weak part and distribution of uniform weight of vacuum chamber. The details of Fixed Stand are designed as shown in Fig. 4. The upper plate is used for alignment and locked to JIGS's by using screws. The lower plate is used for locking to four M16 bolts bonded on the ground. A hollow column is spot welded between upper and lower plates. Due to the insufficient ground flatness at the depot of temporary factory, we need bolts to align the position of Fixed Stand and then overcome the aforementioned ground condition.

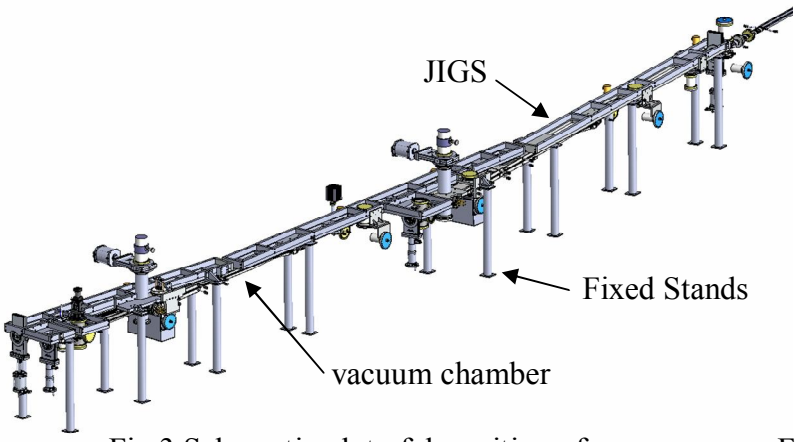


Fig.3 Schematic plot of depositing of vacuum

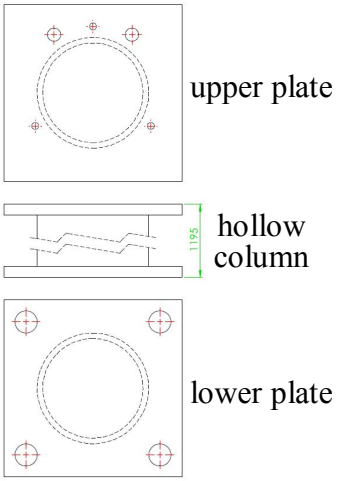


Fig.4 Design of Fixed Stand

3.2 Holes Drilling and Bolts Bonding

To avoid the misalignment and unsatisfied perpendicularity of drilling hole when using a handheld drilling machine, the holes drilling could be performed by locking a drilling machine with a bubble level to the ground, as shown in Fig. 5. Adjusting drilling machine with the bubble level could improve perpendicularity of drilling hole. Locking the drilling machine to the ground could reduce misalignment and vibration. We design a template, as shown in Fig. 6, which has bubble level and screws for adjustment, hole for socket of Laser Tracker's reflector. Bolts bonding process was started with injecting the anchor adhesive in holes. Then adjusting template, putting bolts into holes, waiting 6 hours for concretion, and taking template out. Fig. 7 shows the completion of bolts bonding.

Fig.5 Drilling machine

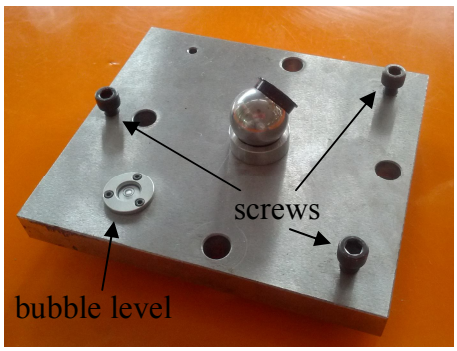


Fig.6 Template for bolts bonding

Fig.7 Bolts bonding

3.3 Installation of Fixed Stand

The installation steps are stated below and illustrated in Fig 8.

1. Screw the lower nuts down.
2. Put the lower concave and convex washers on.
3. Put the Fixed Stand on.
4. Check the position data of the holes for socket of laser tracker's reflector at upper plate instantaneous.
5. Rotate the lower nuts to adjust the Z data to reach +0.1mm.
6. Adjust the lower plate of Fixed Stand to make the X and Y data under ±0.2mm, respectively.
7. Put the upper concave and convex washers on.
8. Screw the upper nuts down and just contact with washers.
9. Use one wrench to fix the lower nuts and use another wrench to screw the upper nuts. Screw 1/5~1/4 circle at one nut then do opposite nut, lateral nut, and opposite nut sequentially 4~6 times until the nuts tighten a little bit.
10. Check the position data obtained from laser tracker instantaneous and tightening the nuts. Adjust the X and Y data under ±0.2mm, as well as Z data reach 0mm by tightening the nuts.

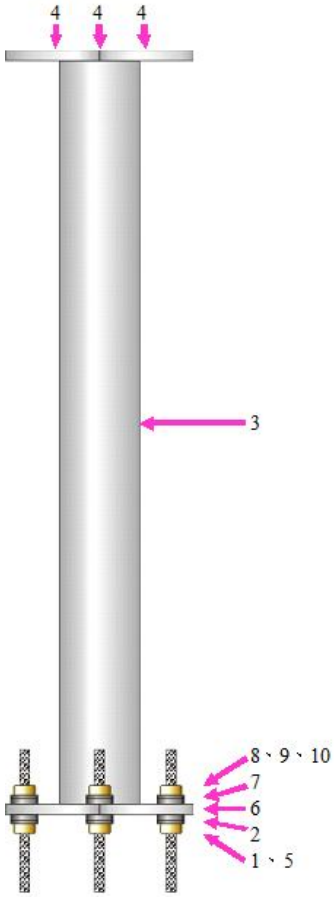


Fig.8 Installation steps

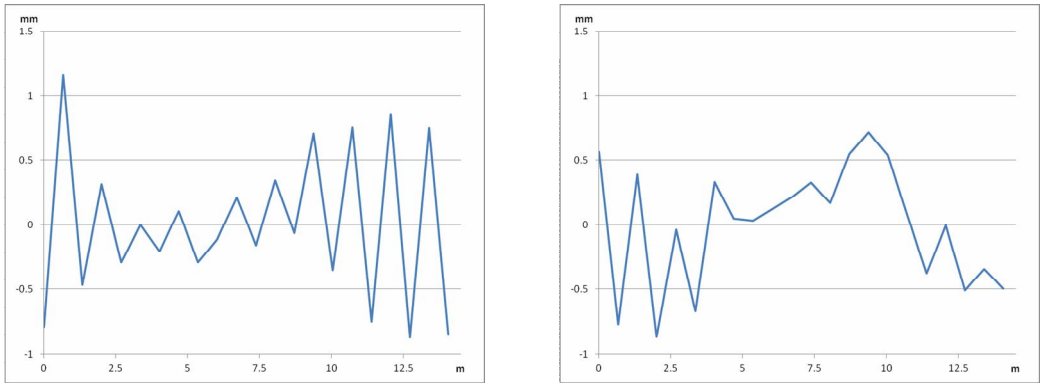
Note that, in step 9, the skill of screwing nuts leads scarcely the incline and torsion of Fixed Stand. In our experience, however, it's not easy to obtain acceptable data from tightening the nuts in step 9. We perform the fine adjustment in step 10.

4-Results of measured data

4.1 Carrier

To obtain the information of surface between H frames and JIG's, we choose some points to construct the surface through a laser tracker. After aligning the H

frames, we compare the displacement of points when moving and lifting a Carrier with staying a Carrier at rest. The results of measured displacement of chosen point are shown in Fig. 9. In Fig.9, we can observe that the maximum elastic deformation of Carrier is under 2mm.



(a) moving (b) lifting

Fig. 9 The record of elastic deformation when a Carrier is moving and lifting

4.2 Fixed Stands

After aligning Fixed Stands, we measure the position through a laser tracker. The deviation of measured position of 17 Fixed Stands is as shown in Fig. 10. In Fig. 10, we can observe that the position deviations of Fixed Stands reach ±0.2mm in X and Y axes, respectively, while ±0.1mm in Z(height) axis.

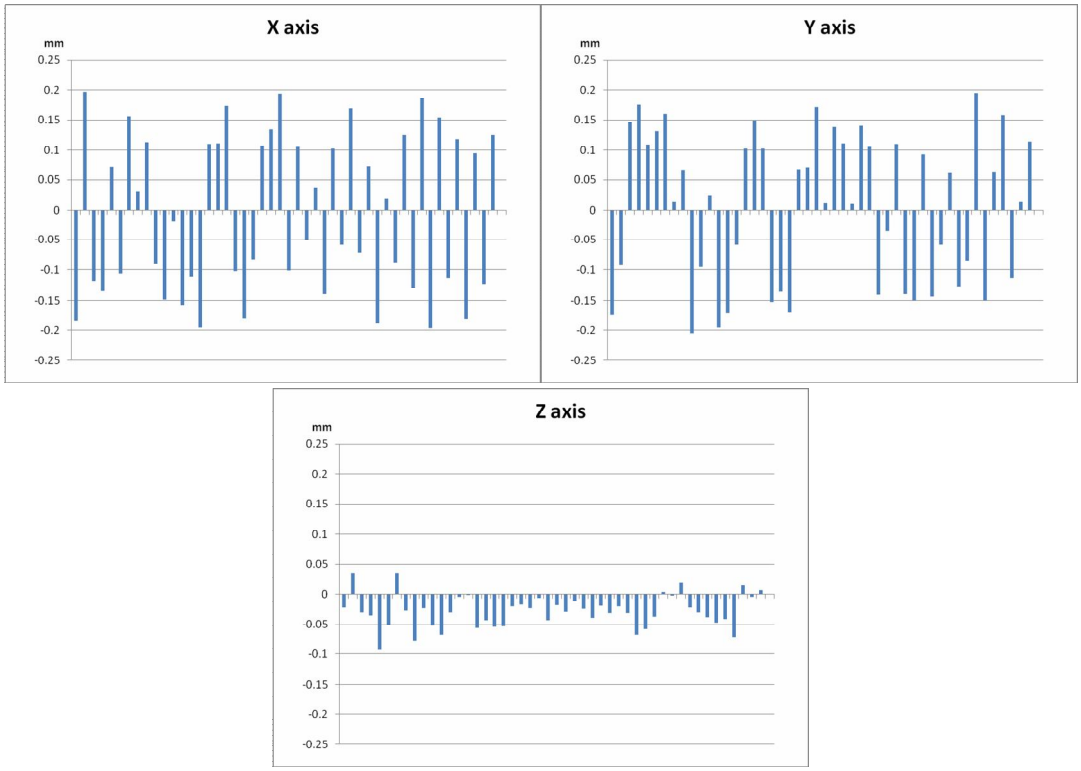


Fig. 10 The deviation of measured position of 17 Fixed Stands

Some pictures of self-designed Carrier and Fixed Stands are shown in Fig. 11-14. In the following figures, we clearly observe that the designed work has been completed and employed to be performed assignment of TPS.

Fig. 11 Moving a vacuum chamber by Carrier.

Fig. 12 Fixed Stands.

Fig. 13 Unloading vacuum chamber on Fixed Stands by Carrier.

Fig. 14 Depositing vacuum chamber on Fixed Stands

5-Conclusion

In this paper, the specific Carrier and Fixed Stand are considered to be designed. The Carrier includes an I beam, worm gear screw jacks, H frames and JIGS's. The JIGS locked with a vacuum chamber. H frames are connected between an I beam and JIGS's. An I beam is the primary part of loading when moving and lifting a Carrier. Fixed Stand is a hollow column part. A cell of vacuum chamber uses 17 Fixed Stands. We adjust four nuts in conjunction with four M16 bolts bonded on the ground to reach the accuracy of position of a Fixed Stand and to overcome the insufficient ground flatness. The measured data obtained from a laser tracker show that the maximum elastic deformation of Carrier is 2mm, the position deviations of Fixed Stand are ±0.2mm with 1mm tolerance in X and Y axes, respectively, while ±0.1mm in Z(height) axis. When a vacuum chamber is moving, lifting, depositing and baking, the design specification of a Carrier and Fixed Stand is available.

References

[1] W.Y. Lai, C.J. Lin, H.C. Ho and T.C. Tseng, "Survey and alignment design for the Taiwan photon source", MDESI conference, June, 2010.